

PAINT ROLLER WITH FLEXURE JOINT

CROSS REFERENCE TO RELATED APPLICATIONS

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This application is a continuation-in-part of United States Application Serial No. 09/490,417, entitled "Paint Roller with Flexure Joint" filed January 24, 2000.

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FIELD OF THE INVENTION

The invention relates to paint rollers.

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BACKGROUND OF THE INVENTION

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Hand-held paint rollers are commonly employed to apply paint to large flat surfaces such as the interior walls of a room and the exterior siding of a residence. Standard paint rollers include a handle, a U-shaped shaft connected to a longitudinal end of the handle, and a tube-receiving frame rotatably connected to the free end of the shaft. The tube-receiving frame is sized to selectively receive and maintain a tubular paint applicator.

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By employing a U-shaped shaft, the standard paint roller centrally positions the tubular paint applicator perpendicular to the longitudinal axis of the handle. This orientation allows a person using the paint roller use a painting motion generally parallel to the axis of the user's forearm.

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While the U-shaped shaft provides an ergonomic orientation of the handle relative to the tubular paint applicator, the shaft possesses some drawbacks. For example, the U-shaped configuration of the shaft renders it difficult to apply paint to a high horizontal joint, such as the joint between a wall and the ceiling in a room. Because the tubular paint applicator is

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5 cylindrical, the applicator cannot contact the wall and/or ceiling within the joint when the applicator is oriented parallel to the joint (*i.e.*, the applicator is rolled towards and away from the joint). Paint can be applied within the joint by orienting the applicator perpendicular to the joint and positioning the free end of the applicator into the joint (*i.e.*, the applicator is rolled along the joint). However, because the U-shaped shaft orientates the tubular paint applicator perpendicular to the handle, the user's forearm must be positioned in-line with the rolling direction of the applicator, thereby requiring the user to be elevated and paint from an awkward and uncomfortable position when painting an elevated horizontal joint.

10 Other drawbacks associated with the U-shaped handle occur when an elongated handle is employed to allow painting of elevated surfaces without use of a ladder or scaffolding. One such drawback is the difficulty in maintaining a distance between the handle and the vertical surface to be painted, which is sufficient to prevent the handle from contacting the surface and marking the surface. This problem is of particular concern as the length of the elongated handle increases because of the arch created in the elongated handle from the forward force applied in order to maintain the applicator in contact with the surface.

15 Accordingly, a need exists for an inexpensive paint roller capable of ergonomically allowing the painting of vertical and horizontal surfaces, including elevated vertical and horizontal surfaces, and vertical and horizontal joints, including elevated vertical and horizontal joints, while standing comfortably on the ground at all times.

20 SUMMARY OF THE INVENTION

25 The invention is a paint roller having a handle, a shaft, a functional element secured to a second end of the shaft and a means for repositioning the shaft and functional element relative to the handle. The repositioning means is interposed between and connects a second end of the handle and a first end of the shaft, and is configured to selectively position the functional element relative to the handle by providing a disengaged condition permitting repositioning of the shaft relative to the handle in at least two degrees of freedom, and an engaged condition

preventing repositioning of the shaft relative to the handle. The engaged condition can be achieved with the shaft in at least two different positions relative to the handle.

In a preferred embodiment, the repositioning means is a flexure joint which includes a spherical member, a receiving member configured and arranged to maintain and selectively engage the spherical member, and a connector in communication with the receiving member for releasably locking the spherical member in position as between at least a first locked position and a second locked position relative to the receiving member. Repositioning of the spherical member as between the first and second locked positions is effective for repositioning the shaft relative to the handle as between a first locked position and a second locked position.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a plan view of a first embodiment of a paint roller in accordance with the present invention wherein the shaft is oriented in a first longitudinally aligned position relative to the handle.

Figure 2 is a plan view of the paint roller shown in Figure 1 wherein the shaft is oriented in a second angularly displaced position relative to the handle.

Figure 3 is a front view of the receiving member portion of the paint roller shown in Figure 1.

Figure 4 is a left side view of the receiving member shown in Figure 3.

Figure 5 is an exploded plan view of a second embodiment of a paint roller in accordance with the present invention.

Figure 6 is a front view of the handle shown in Figure 5.

Figure 7 is an end view of the first end of the handle shown in Figure 5.

Figure 8 is front view of the receiving member shown in Figure 5.

5 Figure 9 is a right side view of the receiving member shown in Figure 5.

Figure 10 is a left side view of the receiving member shown in Figure 5.

10 Figure 11 is a front view of the receiving member shown in Figure 5 with portions of the receiving member removed to depict the transverse bores extending through the receiving member.

Figure 12 is a front view of the spherical member shown in Figure 5.

15 Figure 13 is a side view of the spherical member shown in Figure 5.

Figure 14 is a front view of the fully assembled flexure joint shown in Figure 13.

20 Figure 15 is a right side view of the fully assembled flexure joint shown in Figure 13.

Figure 16 is a left side view of the fully assembled flexure joint shown in Figure 13.

25 Figure 17 is a front view of the assembled shaft and locking mechanism shown in Figure 5.

DETAILED DESCRIPTION OF THE INVENTION

Nomenclature

30 10 Paint Roller

TOP SECRET

- 20 Handle
- 20x Longitudinal Axis of Handle
- 21 First End of Handle
- 22 Second End of Handle
- 23 Grip Portion of Handle
- 24 Neck Portion of Handle
- 29 Longitudinal Bore in Handle
- 30 Shaft
- 31 First End Section of Shaft
- 32 Second End Section of Shaft
- 33 U-Shaped Section of Shaft
- 40 Locking Mechanism
- 41 Distal End of Locking Mechanism
- 50 Flexure Joint
- 60 Spherical Member
- 60x Longitudinal Axis of Spherical Member
- 60y Latitudinal Axis of Spherical Member
- 60z Transverse Axis of Spherical Member
- 70 Collar
- 79 Threaded Bore in Collar
- 80 Receiving Member
- 80x Longitudinal Axis of Receiving Member
- 80y Latitudinal Axis of Receiving Member
- 80z Transverse Axis of Receiving Member
- 81 Shoulder Portion of Receiving Member
- 82 Clamping Portion of Receiving Member
- 83 First Arm
- 83d Distal End of First Arm
- 83p Proximal End of First Arm
- 83i Inner Surface of First Arm
- 83o Outer Surface of First Arm

	84	Second Arm
	84d	Distal End of Second Arm
	84p	Proximal End of Second Arm
	84i	Inner Surface of Second Arm
5	84o	Outer Surface of Second Arm
	85	Threaded Longitudinal Bore in Shoulder Portion of Receiving Member
	86	Transverse Pin Passage in Shoulder Portion of Receiving Member
	87	Gap Separating First and Second Arms
	87d	Distal Region of Gap
10	87m	Middle Region of Gap
	87p	Proximal Region of Gap
	88'	Aperture Through First Arm
	88"	Aperture Through Second Arm
	89'	Connector Receiving Bore Through First Arm
15	89"	Connector Receiving Threaded Bore in Second Arm
	90'	Spacing Adjustment Mechanism Receiving Bore Through First Arm
	90"	Spacing Adjustment Mechanism Receiving Threaded Bore in Second Arm
	91'	Concave Channel Formed in Inner Surface of First Arm
	91"	Concave Channel Formed in Inner Surface of Second Arm
20	100	Connector
	101	Shank of Connector
	102	Head of Connector
	110	Washer
	120	Spacing Adjustment Mechanism
25	121	Shank of Bolt
	122	Head of Bolt
	130	Tube-Receiving Frame
	131	Axially Extending Rods of Tube-receiving Frame
	140	Tubular Paint Applicator
30	x	Longitudinal Direction
	y	Latitudinal Direction

z Transverse Direction

Construction

First Embodiment

One embodiment of the paint roller 10 is shown in Figures 1-4. The paint roller 10 includes a handle 20, a shaft 30, a flexure joint 50, a connector 100, and a tube-receiving frame 130. The tube-receiving frame 130 is configured and arranged to accept a tubular paint applicator 140. The second end 22 of the handle 20 is selectively secured to the first end section 31 of the shaft 30 by the flexure joint 50. The tube-receiving frame 130 is rotatably secured to the second end 32 of the shaft 30.

The handle 20 preferably includes a grip portion 23 and a neck portion 24. The grip portion 23 may be constructed from any number of materials possessing the necessary structural integrity including specifically but not exclusively, aluminum, ceramic, wood and molded plastic. The grip portion 23 is preferably sized to comfortably rest within a user's hand (not shown). In this regard, the grip portion 23 may include finger articulations for enhancing fit with a user's hand. The neck portion 24 extends from the grip portion 23 at the second end 22 of the handle 20 and is preferably made of a rigid material, such as mild steel or stainless steel. The neck portion 24 of the handle 20 terminates at the flexure joint 50. While the grip portion 23 and the neck portion 24 have been described as separate components, the handle 20 may be integrally formed of a single material. In fact, the neck portion 24 can be eliminated. The handle 20 can be configured and arranged with other shapes, sizes, configurations, and/or constructions known in the art.

The handle 20 preferably includes a threaded longitudinal bore 29 accessible from the first end 21 of the handle 20 for receiving and threadably engaging a standard extension pole (not shown).

The shaft **30** forms an appropriate U-shape, and includes a first end section **31**, a second end section **32**, and a U-shaped central section **33**. The first end section **31** is secured to a component of the flexure joint **50**. The second end section **32** is rotatably secured to the tube-receiving frame **130**. The shaft **30** is preferably a rigid rod, formed from any material possessing the necessary structural integrity such as aluminum, mild steel, stainless steel, and molded plastic. The shaft **30** can be configured with any desired configuration, but preferably approximates the ergonomic U-shape of the standard paint roller.

The tube-receiving frame **130** is of a type commonly known in the art and is rotatably secured to the second end **32** of the shaft **30**. In this regard, the tube-receiving frame **130** may include radial bearings (not shown) at either end of the tube-receiving frame **130** to provide rotatable association with the shaft **30**. The tube-receiving frame **130** preferably includes axially extending rods **131** sized to frictionally maintain the tubular paint applicator **140** in position. Other functional elements may also be secured to the second end **32** of the shaft **30** including specifically, but not exclusively, a sweeping brush, a wire brush, a scrapper, a painting pad, and a sanding pad.

The flexure joint **50** is configured to provide repositionable “locked” orientation of the shaft **30** relative to the handle **20**. The flexure joint **50** includes a spherical member **60**, a receiving member **80**, and a connector **100**. In a preferred embodiment, the spherical member **60** is attached at the free end (unnumbered) of the first end section **31** of the shaft **30** and the receiving member **80** is attached to the neck portion **24** of the handle **20**. Alternatively, attachment of the spherical member **60** and the receiving member **80** can be reversed, with the spherical member **60** attached to the neck portion **24** of the handle **20** and the receiving member **80** attached at the free end (unnumbered) of the first end section **31** of the shaft **30**. For purposes of enhancing lucidity of the disclosure, the balance of the detailed description shall be set forth in connection with the embodiment of the paint roller **10** in which the spherical member **60** is attached at the end of the first end section **31** of the shaft **30** and the receiving member **80** is attached to the neck portion **24** of the handle **20**. However, it is to be understood that the disclosure applies equally to the embodiment in which the spherical member **60** is attached to the

neck portion **24** of the handle **20** and the receiving member **80** attached at the free end (unnumbered) of the first end section **31** of the shaft **30**.

The spherical member **60** can be constructed from any material possessing the necessary structural integrity, such as a mild steel or stainless steel ball bearing. The spherical member **60** is preferably constructed from a slightly compressible material capable of structurally surviving the torsion forces placed upon the spherical member **60** during normal use of the paint roller **10**, such as a high durometer rubber. The spherical member **60** preferably has a diameter of approximately 0.687 inches, although other diameters are equally acceptable.

The spherical member **60** preferably has a radial bore (not shown) for accepting insertion of the free end (unnumbered) of the first end section **31** of the shaft **30** and thereby facilitating attachment of the shaft **30** to the spherical member **60**. The spherical member **60** can be attached by any of the attachment techniques known in the art, such as threading, adhesives, frictional fit, welding, etc. The spherical member **60** can also be integrally formed with the shaft **30**.

The receiving member **80** is shown in greater detail in Figures 3 and 4. In a preferred embodiment, the receiving member **80** is generally Y-shaped, defined by a shoulder portion **81** and a clamping portion **82**. The clamping portion **82** includes transversely spaced first and second arms, **83** and **84**, which longitudinally extend in a substantially uniform fashion from the shoulder portion **81**.

A threaded longitudinal bore **85** is preferably provided in the shoulder portion **81** of the receiving member **80** for threadably engaging the neck portion **24** of the handle **20**. A transverse pin passage **86** preferably extends through the shoulder portion **81** and through the longitudinal bore **85**. The transverse pin passage **86** is sized to receive and frictionally maintain a roll pin (not shown) for preventing unintentional loosening of the neck portion **24** from within the longitudinal bore **85** in the shoulder portion **81** of the receiving member **80**. Alternatively, the shoulder portion **81** of the receiving member **80** can be configured to accommodate other forms of attachment to the neck portion **24** of the handle **20** such as by a weld, adhesive, etc. With

these alternative configurations, one or both of the longitudinal bore 85 and the transverse pin passage 86 can be eliminated.

The clamping portion 82 of the receiving member 80 includes opposed first and second arms 83 and 84, separated by a gap 87. In this regard, arms 83 and 84 preferably extend in a substantially identical fashion from the shoulder portion 81 of the receiving member 80. Each of the first arm 83 and second arm 84 has an inner surface 83i and 84i, and an outer surface 83o and 84o, respectively. Transversely aligned apertures 88', 88", and transversely aligned connector receiving bores 89' and 89" extend through the first and second arms 83 and 84, respectively. The apertures 88' and 88" are longitudinally spaced from the connector receiving bores 89' and 89" towards the distal ends 83d and 84d of the first and second arms 83 and 84 respectively.

The first and second arms 83 and 84 are preferably formed such that the outer surfaces 83o and 84o of the arms 83 and 84 are substantially flat and have a width in the range of 0.5 - 1.5 inches, more preferably in the range of 0.75 - 1.25 inches, and most preferably approximately 1 inch. The inner surfaces 83i and 84i of the first and second arms 83 and 84 are also preferably substantially flat with mirror image longitudinally extending concave channels 91' and 91" formed by the inner surfaces 83i and 84i of each arm 83 and 84 respectively. The concave channels 91' and 91" are preferably formed as mirror images, with each channel 91' and 91" extending from the distal end 83d and 84d of the corresponding arm 83 and 84 to at least the apertures 88' and 88" in the corresponding arm 83 and 84. The concave channels 91' and 91" are sized in accordance with the diameter of the spherical member 60 to facilitate initial introduction of the spherical member 60 into frictional engagement within the gap 87 between the arms 83 and 84 and transversely centered within the apertures 88' and 88". Thus in a preferred embodiment, the transverse height of the gap 87 between the arms 83 and 84 is substantially less than the diameter of the spherical member 60 except at the nadirs (unnumbered) of the concave channels 91' and 91" where the transverse height of the gap 87 is only slightly smaller than the diameter of the spherical member 60 so as to facilitate initial introduction of the spherical member 60 within the gap 87 separating the arms 83 and 84 with the spherical member 60 transversely centered within the apertures 88' and 88" in the arms 83

and 84. Alternatively, other assembly techniques may be employed in which the concave channels 91' and 91'' need not be formed.

As depicted in Figure 3, the gap 87 separates the first arm 83 and second arm 84 and extends the entire longitudinal length and lateral width of the clamping portion 82 of the receiving member 80. The gap 87 preferably defines a distal region 87d and a proximal region 87p with the transverse height of the gap 87 in the distal region 87d greater than the height of the gap 87 in the proximal region 87p. In other words, the transverse spacing between the first arm 83 and the second arm 84 is greater within the distal region 87d of the gap 87 than the proximal region 87p of the gap 87. The distal region 87d preferably encompasses the apertures 88' and 88'' and the connector receiving bores 89' and 89''. The transverse height of the distal region 87d is selected to accommodate the spherical member 60 within the gap 87, accommodate passage of the first end section 31 of the shaft 30 into the gap 87 and into engagement with the spherical member 60 retained within the gap 87, and permit lateral pivoting of the first end section 31 of the shaft 30 within the gap 87. More particularly, the transverse height of the distal region 87d is preferably less than the diameter of the spherical member 60 such that the spherical member 60 is retainable between the first arm 83 and the second arm 84 when the connector 100 is in a disengaged condition. In addition, the transverse height of the distal region 87d, the diameter of the spherical member 60 and the thickness of the first end section 31 of the shaft 30 are preferably selected so that the shaft 30 does not interfere with locking engagement of the spherical member 60 between the arms 83 and 84 by actuation of the connector 100. Generally, a transverse height of approximately 0.4 inches is acceptable. Alternatively, other transverse heights are equally acceptable.

As described below, the gap 87 allows the first arm 83 and second arm 84 to be deflected toward or away from one another by actuation of the connector 100 so as to lock the spherical member 60 in position relative to the receiving member 80 when in an engaged condition and allow repositioning of the spherical member 60 relative to the receiving member 80 when in a disengaged condition. A variety of factors can impact the extent to which the first arm 83 and second arm 84 can be deflected, including the material of construction, the longitudinal length of the arms 83 and 84 defined by the longitudinal length of the gap 87, the thickness of the first arm

83 and second arm 84 proximate the shoulder portion 81 of the receiving member 80, the longitudinal placement of the apertures 88' and 88'', and the longitudinal placement of the connector receiving bores 89' and 89''. As shown in Figure 3, the gap 87 can be configured with a proximal region 87p having a transverse height which is less than the transverse height of the distal region 87d for purposes of increasing the longitudinal length of the gap 87 and thereby facilitating deflection of the arms 83 and 84, while providing a strong clamping action. Alternatively, the gap 87 can be formed with a relatively uniform height along the entire longitudinal length of the gap 87.

Transversely aligned and transversely extending apertures 88' and 88'' are formed in the first and second arms 83 and 84 respectively. The apertures 88' and 88'' are configured and arranged to receive and maintain the spherical member 60. In a preferred embodiment, favored for ease of manufacture, the apertures 88' and 88'' extend completely through the respective arm 83 and 84. Alternatively, the apertures 88' and 88'' may be formed as a cylindrical concavity which does not extend completely through the arms 83 or 84, or may be formed as a dimple in the inner surface 83i and 84i of the respective arm 83 and 84. The apertures 88' and 88'' have a diameter which is smaller than the diameter of the spherical member 60 to prevent the spherical member 60 from passing completely through the apertures 88' and 88''. For example, a spherical member 60 having a diameter of 0.687 inches can be satisfactorily accommodated within apertures 88' and 88'' having a diameter of 0.5 inches. Alternatively, other dimensions are equally acceptable.

The transversely aligned connector receiving bores 89' and 89'' in the first and second arms 83 and 84 respectively, are longitudinally spaced from apertures 88' and 88'' towards the shoulder portion 81 of the receiving member 80. The connector receiving bores 89' and 89'' are longitudinally spaced from apertures 88' and 88'' a distance sufficient to prevent the connector 100 from contacting and interfering with rotation of the spherical member 60 when the connector 100 is operably positioned within the connector receiving bores 89' and 89''. However, the connector receiving bores 89' and 89'' are preferably placed in relatively close longitudinal proximity to apertures 88' and 88'' as the actuation force required to lock the spherical member 60 into position is reduced by positioning the connector 100 as close as possible to the distal

ends **83d** and **84d** of the arms **83** and **84** respectively. For example, a center to center spacing of about 0.625 inches from the connector receiving bores **89'** and **89''** to the corresponding apertures **88'** and **88''** in each arm **83** and **84** is effective when the spherical member **60** has a diameter of 0.5 inches and the shank **101** of the connector **100** has a diameter of 0.25 inches.

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The connector receiving bores **89'** and **89''** are configured to selectively retain the connector **100** as between an engaged condition wherein the arms **83** and **84** are deflected towards one another and the spherical member **60** is locked in position, and a disengaged condition wherein the arms **83** and **84** are not deflected and the spherical member **60** can be rotatably repositioned relative to the receiving member **80**. For example, in one embodiment, the connector receiving bore **89'** through the first arm **83** slidably engages the shank **101** of the connector **100** while preventing passage of the head **102** of the connector **100**, while the connector receiving bore **89''** through the second arm **84** is threaded for threadably engaging the shank **101** of the connector **100**. Alternatively, other attachment configurations are equally acceptable.

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The entire receiving member **80**, including the shoulder portion **81** and the clamping portion **82** is preferably a one-piece member integrally formed from a high strength deflectable material such as T6 aluminum.

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The shaft **30** and thereby the tube-receiving frame **130** can be manually repositioned relative to the handle **20** after the connector **100** is loosened. The shaft **30** can be rotated about the longitudinal axis **20x** of the handle **20** by effecting rotation of the spherical member **60** about the longitudinal axis **60x** of the spherical member **60** within the receiving member **80**. In addition, the shaft **30** can be laterally repositioned relative to the handle **20** by effecting rotation of the spherical member **60** about the transverse axis **60z** of the spherical member **60** within the receiving member **80**. Transverse repositioning of the shaft **30** relative to the handle **20** is limited by arms **83** and **84**, which prevent continued transverse movement of the spherical member **60** because the distal ends **83d** and **84d** of the arms **83** and **84** contact the first end section **31** of the shaft **30**. Thus, the flexure joint **50** effectively provides two degrees of freedom of movement.

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5 The flexure joint **50** can be configured and arranged to allow (i) 360° rotation of the shaft **30** about the longitudinal axis **20x** of the handle **20**, and (ii) at least a 30°, preferably at least a 60°, and most preferably at least a 90°, rotation of the shaft **30** about the transverse axis **60z** of the spherical member **60** in both clockwise and counter-clockwise directions from the longitudinal axis **20x** of the handle **20**.

10 Once the shaft **30** and thus the tube-receiving frame **130** and tubular paint applicator **140** is located in the desired angular and rotational position relative to the handle **20**, the shaft **30** can be locked into position by tightening the connector **100** so as to lock the spherical member **60** into position within the clamping portion **82** of the receiving member **80**. The paint roller **10** is then available for use.

15 The tube-receiving frame **130** and tubular paint applicator **140** can be quickly and easily repositioned relative to the handle **20** by loosening the connector **100**, effecting the desired amount of rotational and angular repositioning of the shaft **30** relative to the receiving member **80**, and then retightening the connector **100**.

20 The paint roller **10** with flexure joint **50** of the present invention provides a marked improvement over the standard paint roller design. By providing a user with the ability to easily change orientation of an attached tubular paint applicator **140** relative to the handle **20**, a wide variety of new applications for the paint roller **10** are now available. For example, a simple rotation of the shaft **30** relative to the handle **20** facilitates painting a corner. Additionally, transversely angling the tubular paint applicator **140** from the longitudinal axis **20x** of the handle **20** facilitates the horizontal painting of elevated surfaces. Finally, the ability to adjust the position of the tubular paint applicator **140** relative to the handle **20** allows the paint roller **10** to be used in a more ergonomically correct position for a variety of painting directions and positions, thus minimizing the stresses placed upon the wrist, arm, shoulder and back of a user.

30 Although the present invention has been described with reference to preferred embodiments, workers skilled in the art recognize that changes may be made in form and detail

without departing from the spirit and scope of the invention. For example, the paint roller 10 of the present invention has been described as relating to a standard size. It would be recognized by those skilled in the art that the paint roller 10 can be constructed to substantially any desired sized. In addition, the paint roller 10 may utilize a shaft 30, which does not have the standard U-shaped section 33. Similarly, while the spherical member 60 has been described as round with a smooth surface, other shapes and surface textures, such as an egg shaped member with a knurled surface, may also be employed.

In light of the disclosure provided herein, other options for providing the desired lateral repositionability of the shaft 30 relative to the handle 20 would be known to those skilled in the art. One such option is replacement of the spherical member 60 and associated apertures 88' and 88'' in the arms 83 and 84 with a spindle (not shown) rotatably mounted within bearings (not shown) in the arms 83 and 84. The spindle version would further replace the connector 100 and connector receiving bores 89' and 89'' in the arms 83 and 84 with a releasable catch system such as a ratchet-type assembly (not shown) or a pin retention system (not shown) for locking the spindle into position.

It is not necessary that the flexure joint 50 provide the multiple degrees of freedom offered by the preferred embodiments disclosed herein. The claimed invention includes paint rollers 10 having a flexure joint 50, which provides a single degree of freedom.

Second Embodiment

A second embodiment of the paint roller 10 is shown in Figures 5 through 17. The second embodiment of the paint roller 10 is similar in many respects to the first embodiment of the paint roller 10. Accordingly, similar components and features will be identified by the same reference numeral.

Referring to Figure 5, the paint roller 10 includes a handle 20, a shaft 30, a locking mechanism 40, a flexure joint 50, a connector 100, a spacing adjustment mechanism 120, and a tube-receiving frame 130. The tube-receiving frame 130 is configured and arranged to accept a

tubular paint applicator **140**. The second end **22** of the handle **20** is selectively secured to the first end section **31** of the shaft **30** by the flexure joint **50**. The tube-receiving frame **130** is rotatably secured to the second end **32** of the shaft **30**.

The handle **20** preferably includes a grip portion **23** and a neck portion **24**. The grip portion **23** may be constructed from any number of materials possessing the necessary structural integrity including specifically but not exclusively, aluminum, ceramic, wood and molded plastic. The grip portion **23** is preferably sized to comfortably rest within a user's hand (not shown). In this regard, the grip portion **23** may include finger articulations for enhancing fit with a user's hand. The neck portion **24** extends from the grip portion **23** at the second end **22** of the handle **20** and is preferably made of a rigid material, such as mild steel or stainless steel. The neck portion **24** of the handle **20** terminates at the flexure joint **50**. While the grip portion **23** and the neck portion **24** have been described as separate components, the handle **20** may be integrally formed of a single material. In fact, the neck portion **24** can be eliminated. The handle **20** can be configured and arranged with other shapes, sizes, configurations, and/or constructions known in the art.

The handle **20** preferably includes a threaded longitudinal bore **29** accessible from the first end **21** of the handle **20** for receiving and threadably engaging a standard extension pole (not shown).

The shaft **30** forms an appropriate U-shape, and includes a first end section **31**, a second end section **32**, and a U-shaped central section **33**. The first end section **31** is secured to a component of the flexure joint **50**. The second end section **32** is rotatably secured to the tube-receiving frame **130**. The shaft **30** is preferably a rigid rod, formed from any material possessing the necessary structural integrity such as aluminum, mild steel, stainless steel, and molded plastic. The shaft **30** can be configured with any desired configuration, but preferably approximates the ergonomic U-shape of the standard paint roller.

The tube-receiving frame **130** is of a type commonly known in the art and is rotatably secured to the second end **32** of the shaft **30**. In this regard, the tube-receiving frame **130** may

include radial bearings (not shown) at either end of the tube-receiving frame 130 to provide rotatable association with the shaft 30. The tube-receiving frame 130 preferably includes axially extending rods 131 sized to frictionally maintain the tubular paint applicator 140 in position. Other functional elements may also be secured to the second end 32 of the shaft 30 including specifically, but not exclusively, a sweeping brush, a wire brush, a scrapper, a painting pad, and a sanding pad.

The flexure joint 50 is configured to provide repositionable "locked" orientation of the shaft 30 relative to the handle 20. The flexure joint 50 includes a spherical member 60, a collar 70, a receiving member 80, a connector 100, and a spacing adjustment mechanism 120. In a preferred embodiment, the spherical member 60 is attached to the free end (unnumbered) of the first end section 31 of the shaft 30 and the receiving member 80 is attached to the neck portion 24 of the handle 20. Alternatively, attachment of the spherical member 60 and the receiving member 80 can be reversed, with the spherical member 60 attached to the neck portion 24 of the handle 20 and the receiving member 80 attached to the free end (unnumbered) of the first end section 31 of the shaft 30. For purposes of enhancing lucidity of the disclosure, the balance of the detailed description shall be set forth in connection with the embodiment of the paint roller 10 in which the spherical member 60 is attached to the free end (unnumbered) of the first end section 31 of the shaft 30 and the receiving member 80 is attached to the neck portion 24 of the handle 20. However, it is to be understood that the disclosure applies equally to the embodiment in which the spherical member 60 is attached to the neck portion 24 of the handle 20 and the receiving member 80 attached to the free end (unnumbered) of the first end section 31 of the shaft 30.

The spherical member 60 can be constructed from any material possessing the necessary structural integrity, such as a mild steel or stainless steel ball bearing. The spherical member 60 is preferably constructed from a slightly compressible material capable of structurally surviving the torsion forces placed upon the spherical member 60 during normal use of the paint roller 10, such as a high durometer rubber. The spherical member 60 preferably has a diameter of approximately 0.687 inches, although other diameters are equally acceptable.

The spherical member 60 can be directly attached to the free end (unnumbered) of the first end section 31 of the shaft 30. In a preferred embodiment, the spherical member 60 is molded around a radially extending collar 70 with a radially extending threaded bore 79 provided in the collar 70 for threadably engaging the free end (unnumbered) of the first end section 31 of the shaft 30 and thereby providing rotatable attachment of the shaft 30 to the spherical member 60.

A locking mechanism 40 is provided for locking the shaft 30 in a selected rotational position about the longitudinal axis 60x of the spherical member 60 when in an engaged condition and allow rotational repositioning of the shaft 30 about the longitudinal axis 60x of the spherical member 60 without rotation of the spherical member 60 when in a disengaged condition. A preferred locking mechanism 40, shown in Figures 5, 11 and 17, is a wing nut 40 having a longitudinal threaded bore (not shown) extending completely through the wing nut 40 for threadably engaging the threaded first end section 31 of the shaft 30. The wing nut 40 is effective for locking the shaft 30 in a selected rotational position about the longitudinal axis 60x of the spherical member 60 by rotating the wing nut 40 in a first direction relative to the first end section 31 of the shaft 30 until the distal end 41 of the wing nut 40 engages the collar 70. The wing nut 40 can be disengaged for allow rotational repositioning of the shaft 30 about the longitudinal axis 60x of the spherical member 60 by simply rotating the wing nut 40 in a reverse direction relative to the first end portion 31 of the shaft 30 until the distal end 41 of the wing nut 40 disengages the collar 70.

The receiving member 80 is shown in greater detail in Figures 8 through 11. In a preferred embodiment, the receiving member 80 is generally Y-shaped, defined by a shoulder portion 81 and a clamping portion 82. The clamping portion 82 includes transversely spaced first and second arms, 83 and 84, which longitudinally extend in a substantially uniform fashion from the shoulder portion 81.

A threaded longitudinal bore 85 is preferably provided in the shoulder portion 81 of the receiving member 80 for threadably engaging the neck portion 24 of the handle 20.

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The clamping portion **82** of the receiving member **80** includes opposed first and second arms **83** and **84**, separated by a gap **87**. In this regard, arms **83** and **84** preferably extend in a substantially identical fashion from the shoulder portion **81** of the receiving member **80**. Each of the first arm **83** and second arm **84** has an inner surface **83i** and **84i**, and an outer surface **83o** and **84o**, respectively. Transversely aligned apertures **88'** and **88''**, transversely aligned connector receiving bores **89'** and **89''**, and transversely aligned spacing adjustment mechanism receiving bores **90'** and **90''** extend through the first and second arms **83** and **84**, respectively. The apertures **88'** and **88''** are longitudinally spaced from the connector receiving bores **89'** and **89''** towards the distal ends **83d** and **84d** of the first and second arms **83** and **84** respectively. The adjustment mechanism receiving bores **90'** and **90''** are longitudinally spaced from the connector receiving bores **89'** and **89''** towards the proximal ends **83p** and **84p** of the first and second arms **83** and **84** respectively.

The first and second arms **83** and **84** are preferably formed such that the outer surfaces **83o** and **84o** of the arms **83** and **84** are substantially flat and have a width in the range of 0.5 - 1.5 inches, more preferably in the range of 0.75 - 1.25 inches, and most preferably approximately 1 inch. The inner surfaces **83i** and **84i** of the first and second arms **83** and **84** are also preferably substantially flat with mirror image longitudinally extending concave channels **91'** and **91''** formed by the inner surfaces **83i** and **84i** of each arm **83** and **84** respectively. The concave channels **91'** and **91''** are preferably formed as mirror images, with each channel **91'** and **91''** extending from the distal ends **83d** and **84d** of the corresponding arm **83** and **84** to at least the apertures **88'** and **88''** in the corresponding arm **83** and **84**. The concave channels **91'** and **91''** are sized in accordance with the diameter of the spherical member **60** to facilitate initial introduction of the spherical member **60** into frictional engagement within the gap **87** between the arms **83** and **84** and transversely centered within the apertures **88'** and **88''**. Thus in a preferred embodiment, the transverse height of the gap **87** between the arms **83** and **84** is substantially less than the diameter of the spherical member **60** except at the nadirs (unnumbered) of the concave channels **91'** and **91''** where the transverse height of the gap **87** is only slightly smaller than the diameter of the spherical member **60** so as to facilitate initial introduction of the spherical member **60** within the gap **87** separating the arms **83** and **84** with the spherical member **60** transversely centered within the apertures **88'** and **88''** in the arms **83**

and 84. Alternatively, other assembly techniques may be employed in which the concave channels 91' and 91'' need not be formed.

As depicted in Figures 8 and 11, the gap 87 separates the first arm 83 and second arm 84 and extends the entire longitudinal length and lateral width of the clamping portion 82 of the receiving member 80. The gap 87 preferably defines a distal region 87d, a middle region 87m and a proximal region 87p with the transverse height of the gap 87 in the distal region 87d greater than the height of the gap 87 in the middle region 87m and the transverse height of the gap 87 in the proximal region 87p greater than the height of the gap 87 in the distal region 87d. In other words, the transverse spacing between the first arm 83 and the second arm 84 is greatest in the proximal region 87p and least in the middle region 87m. The distal region 87d preferably encompasses the apertures 88' and 88'' and the connector receiving bores 89' and 89'', while the middle region 87m preferably encompasses the adjustment mechanism receiving bores 90' and 90''. The transverse height of the distal region 87d is selected to accommodate the spherical member 60 within the gap 87, accommodate passage of the collar 70 and the first end section 31 of the shaft 30 into the gap 87 and into engagement with the spherical member 60 retained within the gap 87, and permit lateral pivoting of the collar 70 and the first end section 31 of the shaft 30 within the gap 87. More particularly, the transverse height of the distal region 87d is preferably less than the diameter of the spherical member 60 such that the spherical member 60 is retainable between the first arm 83 and the second arm 84 when the connector 100 is in a disengaged condition. In addition, the transverse height of the distal region 87d, the diameter of the spherical member 60 and the thickness of the first end section 31 of the shaft 30 are preferably selected so that the shaft 30 does not interfere with locking engagement of the spherical member 60 between the arms 83 and 84 by actuation of the connector 100. Generally, a transverse height of approximately 0.4 inches is acceptable. Alternatively, other transverse heights are equally acceptable.

As described below, the gap 87 allows the first arm 83 and second arm 84 to be deflected toward or away from one another by (i) actuation of the connector 100 so as to lock the spherical member 60 in position relative to the receiving member 80 when in an engaged condition and allow repositioning of the spherical member 60 relative to the receiving member 80 when in a

disengaged condition, and (ii) actuation of the spacing adjustment mechanism 120 so as to adjustment the transverse height of the distal region 87d of the gap 87 from time to time and thereby maintain a desired tolerance between the diameter of the spherical member 60 and the height of the distal region 87d of the gap 87 as the components are subjected to wear and tear. A variety of factors can impact the extent to which the first arm 83 and second arm 84 can be deflected by the connector 100, including the material of construction, the longitudinal length of the arms 83 and 84 defined by the longitudinal length of the gap 87, the thickness of the first arm 83 and second arm 84 proximate the shoulder portion 81 of the receiving member 80, the longitudinal placement of the apertures 88' and 88'', the longitudinal placement of the connector receiving bores 89' and 89'', and the longitudinal placement of the spacing adjustment receiving bores 90' and 90''. As shown in Figures 8 and 11, the gap 87 can be configured with a proximal region 87p for purposes of facilitating deflection of the arms 83 and 84 towards one another when the spacing adjustment mechanism 120 is actuated (*i.e.*, tightened). Alternatively, the gap 87 can be formed with a relatively uniform height along the entire longitudinal length of the gap 87.

Transversely aligned and transversely extending apertures 88' and 88'' are formed in the first and second arms 83 and 84 respectively. The apertures 88' and 88'' are configured and arranged to receive and maintain the spherical member 60. In a preferred embodiment, favored for ease of manufacture, the apertures 88' and 88'' extend completely through the respective arm 83 and 84. Alternatively, the apertures 88' and 88'' may be formed as a cylindrical concavity which does not extend completely through the arm 83 or 84, or may be formed as a dimple in the inner surfaces 83i and 84i of the respective arms 83 and 84. The apertures 88' and 88'' have a diameter which is smaller than the diameter of the spherical member 60 to prevent the spherical member 60 from passing completely through the apertures 88' and 88''. For example, a spherical member 60 having a diameter of 0.687 inches can be satisfactorily accommodated within apertures 88' and 88'' having a diameter of 0.5 inches. Alternatively, other dimensions are equally acceptable.

The transversely aligned connector receiving bores 89' and 89'' in the first and second arms 83 and 84 respectively, are longitudinally spaced from apertures 88' and 88'' towards the

shoulder portion **81** of the receiving member **80**. The connector receiving bores **89'** and **89''** are longitudinally spaced from apertures **88'** and **88''** a distance sufficient to prevent the connector **100** from contacting and interfering with rotation of the spherical member **60** when the connector **100** is operably positioned within the connector receiving bores **89'** and **89''**. However, the connector receiving bores **89'** and **89''** are preferably placed in relatively close longitudinal proximity to apertures **88'** and **88''** as the actuation force required to lock the spherical member **60** into position is reduced by positioning the connector **100** as close as possible to the distal ends **83d** and **84d** of the arms **83** and **84** respectively. For example, a center to center spacing of about 0.625 from the connector receiving bores **89'** and **89''** to the corresponding apertures **88'** and **88''** in each arm **83** and **84** is effective when the spherical member **60** has a diameter of 0.5 inches and the shank **101** of the connector **100** has a diameter of 0.25 inches.

The connector receiving bores **89'** and **89''** are configured to selectively retain the connector **100** as between an engaged condition wherein the arms **83** and **84** are deflected towards one another and the spherical member **60** is locked in position, and a disengaged condition wherein the arms **83** and **84** are not deflected and the spherical member **60** can be rotatably repositioned relative to the receiving member **80**. For example, in one embodiment, the connector receiving bore **89'** through the first arm **83** slidably engages the shank **101** of the connector **100** while preventing passage of the head **102** of the connector **100**, while the connector receiving bore **89''** through the second arm **84** is threaded for threadably engaging the shank **101** of the connector **100**. Alternatively, other attachment configurations are equally acceptable.

The transversely aligned spacing adjustment bores **90'** and **90''** in the first and second arm **83** and **84** respectively, are longitudinally spaced from the connector receiving bores **89'** and **89''** towards the shoulder portion **81** of the receiving member **80**. The spacing adjustment bores **90'** and **90''** are longitudinally spaced from the connector receiving bores **89'** and **89''** a distance effective for ensuring that users can readily attain the actuation force required to lock the spherical member **60** into position by hand actuation of the connector **100**. For example, a center to center spacing of about 0.75 inches from the spacing adjustment bores **90'** and **90''** to the corresponding connector receiving bores **89'** and **89''** in each arm **83** and **84** is generally

effective when the arms **83** and **84** are constructed from aluminum and have a lateral thickness of 0.5 inches in the distal region **87d** of the gap **87**.

The spacing adjustment bores **90'** and **90''** are configured to retain the spacing adjustment mechanism **120** and allow a periodic decrease in the transverse height of the distal region **87d** of the gap **87** to compensate for wear and tear of the components by actuation of the spacing adjustment mechanism **120**. For example, in one embodiment, the spacing adjustment bore **90'** through the first arm **83** slidably engages the shank **121** of the spacing adjustment mechanism **120** while preventing passage of the head **122** of the spacing adjustment mechanism **120**, while the spacing adjustment bore **90''** through the second arm **84** is threaded for threadably engaging the shank **121** of the spacing adjustment mechanism **120**. Alternatively, other attachment configurations are equally acceptable.

The entire receiving member **80**, including the shoulder portion **81** and the clamping portion **82** is preferably a one-piece member integrally formed from a high strength deflectable material such as T6 aluminum.

The shaft **30** and thereby the tube-receiving frame **130** can be manually repositioned relative to the handle **20** after the locking mechanism **40** and/or the connector **100** is loosened. Upon loosening the locking mechanism **40**, the shaft **30** can be rotated about the longitudinal axis **20x** of the handle **20** by effecting rotation of the first end **31** of the shaft **30** within the collar **70** retained within the spherical member **60**. Upon loosening the connector **100**, the shaft **30** can be laterally repositioned relative to the handle **20** by effecting rotation of the spherical member **60** about the transverse axis **60z** of the spherical member **60** within the receiving member **80**. Transverse repositioning of the shaft **30** relative to the handle **20** is limited by arms **83** and **84**, which prevent continued transverse movement of the spherical member **60** when the distal ends **83d** and **84d** of the arms **83** and **84** contact the collar **70** or first end section **31** of the shaft **30**.

The combination of the first end **31** of the shaft **30**, the collar **70** and the locking mechanism **40** can be configured, arranged and connected to allow 360° rotation of the shaft **30** about the longitudinal axis **20x** of the handle **20**.

The flexure joint **50** can be configured and arranged to allow at least a 30°, preferably at least a 60°, and most preferably at least a 90°, rotation of the shaft **30** about the transverse axis **60z** of the spherical member **60** in both clockwise and counter-clockwise directions from the longitudinal axis **20x** of the handle **20**.

Once the shaft **30** and thus the tube-receiving frame **130** and tubular paint applicator **140** is located in the desired angular and rotational position relative to the handle **20**, the shaft **30** can be locked into position by tightening the locking mechanism **40** and the connector **100** so as to lock the spherical member **60** into position within the clamping portion **82** of the receiving member **80**. The paint roller **10** is then available for use.

The tube-receiving frame **130** and tubular paint applicator **140** can be quickly and easily repositioned relative to the handle **20** by loosening one or both of the locking mechanism **40** and the connector **100**, depending upon the need to rotate about shaft **30** about the longitudinal **20x** and/or transverse **20z** axes of the handle **20** to achieve the desired repositioning, effecting the desired amount of rotation of the shaft **30** relative to the receiving member **80**, and then retightening the locking mechanism **40** and/or connector **100**.

The paint roller **10** with flexure joint **50** of the present invention provides a marked improvement over the standard paint roller design. By providing a user with the ability to easily change orientation of an attached tubular paint applicator **140** relative to the handle **20**, a wide variety of new applications for the paint roller **10** are now available. For example, a simple rotation of the shaft **30** relative to the handle **20** facilitates painting a corner. Additionally, transversely angling the tubular paint applicator **140** from the longitudinal axis **20x** of the handle **20** facilitates the horizontal painting of elevated surfaces. Finally, the ability to adjust the position of the tubular paint applicator **140** relative to the handle **20** allows the paint roller **10** to be used in a more ergonomically correct position for a variety of painting directions and positions, thus minimizing the stresses placed upon the wrist, arm, shoulder and back of a user.

Although the present invention has been described with reference to preferred embodiments, workers skilled in the art recognize that changes may be made in form and detail without departing from the spirit and scope of the invention. For example, the paint roller 10 of the present invention has been described as relating to a standard size. It would be recognized by those skilled in the art that the paint roller 10 can be constructed to substantially any desired sized. In addition, the paint roller 10 may utilize a shaft 30, which does not have the standard U-shaped section 33. Similarly, while the spherical member 60 has been described as round with a smooth surface, other shapes and surface textures, such as an egg shaped member with a knurled surface, may also be employed.

In light of the disclosure provided herein, other options for providing the desired lateral repositionability of the shaft 30 relative to the handle 20 would be known to those skilled in the art. One such option is replacement of the spherical member 60 and associated apertures 88' and 88'' in the arms 83 and 84 with a spindle (not shown) rotatably mounted within bearings (not shown) in the arms 83 and 84. The spindle version would further replace the connector 100 and connector receiving bores 89' and 89'' in the arms 83 and 84 with a releasable catch system such as a ratchet-type assembly (not shown) or a pin retention system (not shown) for locking the spindle into position.

It is not necessary that the flexure joint 50 provide the multiple degrees of freedom offered by the preferred embodiments disclosed herein. The claimed invention includes paint rollers 10 having a flexure joint 50, which provides fewer degrees of freedom.